On the Scales of Maps. By L. M. Haupt, Prof. of Civil Engineering Towne Scientific School.

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The object of this paper is to attempt if possible the removal of the ambiguities existing in regard to the use of ratios as expressing the scales of maps and degrees of slopes.

Mathematical authorities are by no means agreed concerning the definition of the term ratio. They all maintain that it is an expression for the relation existing between two quantities, but differ in the manner of determining the value of this relation; some, as Peck, Davies, Robinson and others, divide the second quantity or consequent by the first or antecedent; some, as Hutton, Alsop, Ray and others, divide the first by the second quantity, and still a third class, as Chauvenet and others, define it as being the quotient obtained by dividing one quantity by another. It may therefore be either $\frac{a}{b}$ or $\frac{b}{a}$, 2,000,000, or $\frac{1}{2000000}$.

The same confusion is found to exist in designating the scales of maps and drawings. Some publishers and engineers giving it as so many miles, or other denomination, to the inch; others, as so many inches to the mile. Again in expressing slopes many authorities use the tang. of the angle made with the horizon, that is the height divided by the base ($\frac{a}{b}$) while others use the co-tang. or $\frac{b}{a}$.

Now if we consider the manner of obtaining the value of the ratio in a Geometrical Series or progression where *no* ambiguity exists, we find that as each subsequent term is obtained from its predecessor by multiplying by a constant factor called the ratio, so to obtain this factor or ratio we must necessarily divide any term by the *preceding* one, and as this is the only way in which its value can be determined, it establishes a rule which should be made to apply to all other cases.

We should then define a *ratio as being the expression for the value of the relation existing between two quantities,* and as *obtained by dividing the* SECOND *by the* FIRST.

The query then arises as to which quantity should be considered the first and which the second, and we answer that the *given material object* to be represented by the map or drawing is the *Unit or measure* with which the other is to be compared. The map or drawing may be made of any convenient size, but the object to be represented is already fixed or constant in its dimensions, and hence, as the unit or standard of comparison, should be made the *divisor*, or denominator of the quantity expressing the ratio; it is consequently the antecedent or first quantity. To illustrate, let it be required to determine the ratio between a map and its original in nature.

The tract to be delineated in miniature is the fixed object, invariable in size, which is to be compared with the plot representing it, and which may be made larger or smaller according to circumstances, hence it become the unit of comparison, and is the antecedent or first quantity, and as such the denominator of the fraction expressing the ratio. The formula will then be:

Field : Plot $= \frac{P}{F}$. P and F being always reduced to the same denomination.

Thus a scale of $\frac{1}{5280}$ is 5280 ft. of field to 1′ of map or one mile to 1 ft. $= \frac{1}{12}$ of a mile to 1″, and not 12″ to 1 mile

It is evidently *incorrect* therefore to indicate the scales of maps as so many inches to a mile as is frequently done. Take the case of the recent Geological maps of one of our sister states said to be plotted on a scale of 3″ to 1 m. or 3″ to 63,360″ $= \frac{63360}{3} = 21{,}120$ that is to say the map is 21,120 times larger than the state itself, a manifest absurdity resulting from considering the *map* as the first quantity or standard rather than the field itself.

In such cases errors of interpretation can scarcely arise as the intention is so evident, but there are numerous others that may lead to misconstruction, as where the drawings of small objects are nearly of the same size as the things represented—thus a scale of $\frac{1}{2}$″ to 1″ would confuse a mechanic unless he happened to know which was the larger, the object or the drawing.

So the expression $\frac{1}{4}$″ to 1′ is likewise incorrect as it is the reciprocal of the ratio intended—the inches evidently referring to the drawing and the foot to the object. As it stands, applying the definition of ratio as deduced, it will be equal to $12 \div \frac{1}{4} = 48$, making the drawing 48 times the size of the model—it should be 1′ to $\frac{1}{4}$″.

If it be remembered that *the antecedent always refers to the given object* and *the consequent to the drawing*, no difficulty can arise. It will always happen then that if the drawing is on a smaller scale than the thing delineated, the ratio will be a *proper* fraction ; if larger, an improper fraction, and if equal the value will be unity, or $\frac{1}{1}$.

It is hardly necessary to call attention to the fact that the number of scales in use is practically infinite, and that serious inconvenience results therefrom to Engineers and Surveyors whose work extends over several counties or states, making it frequently necessary to re-draw large sections of country. In compiling atlases it is the practice of publishers to vary the scales according to the amount of territory to be represented that the sheet may be filled up, but nothing is gained thereby since the scale used for the greatest area to be represented will show with equal clearness all the features of any other area. Moreover the eye becomes accustomed to estimating distances on the maps, with sufficient accuracy for a reconnaissance, when the scale is uniform, but when variable it leads to great confusion, and especially when the publisher has neglected to indicate the scale, as sometimes happens.

It is very desirable to establish, if possible either by recommendations of scientific societies or by general laws, some conventional scales for maps of various sizes. Taking a state of medium area as N. Y. or Penna. for the unit, and reducing it to a convenient size sheet of paper, say 4×3 ft., would require a scale of $\frac{1}{400000}$, the same as is used by the U. S. Coast Survey for general charts and reconnaisance, but too small for most other purposes. Larger states could be plotted on the same scale by dissecting

them. Foreign countries conducting Geodetic Surveys have adopted such a system. In Prussia, Austria and Switzerland the plane table sheet are plotted on a scale of $\frac{1}{25000}$. In Italy the field work is plotted on a scale of $\frac{1}{50000}$, and in Sweden $\frac{1}{100000}$. The older British charts and maps were made on a scale of 1 m. to 1″ or $\frac{1}{63360}$, and the later maps of 1 m. to 6″ or $\frac{1}{10560}$, but these latter, while not being large enough to show parish boundaries with sufficient accuracy, require about six times the amount of labor in their preparation and are inconvenient. The scale used by Prussia and Switzerland for general maps is $\frac{1}{100000}$, or one fourth that of the detail sheets obtained from the plane table surveys.

Populous, cultivated and mineral districts in Great Britain are plotted on a scale of $\frac{1}{2500} = 1$ m. to 25.344″, partially cultivated and thinly settled districts, on a scale of 1 m. to 6″ $= \frac{1}{10560}$. For the plans of cities of over 4000 inhabitants a scale of $\frac{1}{500}$ or 1 m. to 10.56 feet is used, and for towns and villages $\frac{1}{1056}$ or 1 m. to 5 ft. is general.

Numerous other instances might be cited showing the great variety of scales in use, but these will suffice. It is evident that in Government or State Surveys some systematic connection may readily be established between the several scales used, and it is very desirable that this uniformity of scale be made more general. The scale adopted should be just large enough to show clearly all necessary detail. Anything more than this is a wasteful expenditure of time and money.

For general maps of States showing intercommunications, a scale of $\frac{1}{1000000}$ will be found sufficiently large.

For maps of counties, *in toto*, a scale of $\frac{1}{50000}$ will enable all necessary features to be clearly represented; this scale applied to Lycoming Co., the largest in Penna., would require a map $6\frac{1}{2} \times 4\frac{1}{6}$ ft. For townships the scale of $\frac{1}{25000}$ is quite large enough, and furnishes an admirable size for the projection of Geological data.

For cities, towns and villages some decimal, sub-multiples of the above scales should be used.

Cadastral maps of farms, parks or estates may be plotted on scales of $\frac{1}{250}$, $\frac{1}{500}$, $\frac{1}{1000}$, etc.

In indicating the degrees of slopes or the bater of retaining walls, the natural tangent of the angle which the slope makes with the horizon should invariably be used.

To save time in determining the relative values of some of the most important scales in use, and to aid in introducing the metric system of lengths, I have with the assistance of Messrs. Wm. M. Potts and J. W. Van Osten, Jr., prepared the accompanying tables of equivalents. The first, gives the number of Miles, Kilometers, Poles, Chains, Yards, Meters and Feet of territory which are equivalent to one inch of map for any given scale. The second, is the reciprocal of the first, and states the amount of map surface which would be covered by any one or more of the above units, for any scale.

Table of Map Equivalents giving for each

No.	Scale.	Miles,	Kilometers,	Chains,	Poles,
1	1/7,349,760	116.	186.6821	9280.0000	37120.0000
2	1/2,090,880	33.	53.1078	2640.000	10560.00
3	1/1,267,200	20.	32.18663	1600.000	6400.00
4	1/1,200,000	18.9393	30.4791	1515.15	6060.60
5	1/1,013,760	16.	25.7492.	1280.00	5120.00
6	1/1,000,000	15.7828	25.3992	1261.62	5046.50
7	1/811,008	12.8000	20.5994	1024.00	4096.00
8	1/760,320	12.	19.3129	960.00	3840.00
9	1/633,000	10.0221	16.1286	801.768	3207.07
10	1/633,600	10.	16.09329	800.00	3200.00
11	1/600,000	9.4696	15.2398	757.575	3030.30
12	1/506,880	8.	12.87456	640.00	2560.00
13	1/500,000	7.8914	12.6996	631.313	2525.25
14	1/400,000	6.3131	10.1597	505.050	2020.20
15	1/380,160	6.	9.65587	480.00	1920.00
16	1/375,000	5.9185	9.5239	473.48	1893.92
17	1/316,800	5.	8.04664	400.00	1600.00
18	1/300,000	4.7348	7.61992	378.78	1515.15
19	1/240,000	3.7878	6.09570	303.03	1212.12
20	1/200,000	3.15656	5.07985	252.525	1010.10
21	1/190,080	3.	4.827935	240.00	960.00
22	1/180,000	2.5252	4.0638	202.02	808.08
23	1/150,000	2.36742	3.80496	189.39	757.57
24	1/126,728	2.	3.21866	160.00	640.0
25	1/120,000	1.89393	3.05784	151.515	606.06
26	1/100,000	1.57828	2.53995	126.26	505.05
27	1/80,000	1.2626	2.0319	101.01	404.04
28	1/79,200	1.2500	2.01166	100.00	400.00
29	1/76,800	1.21212	1.9604	96.967	387.87
30	1/63,360	1.	1.6093	80.00	320.00
31	1/60,000	0.94696	1.52392	75.75	303.03
32	1/59,400	0.9375	1.508737	75.00	300.0
33	1/50,000	0.78914	1.26996	63.131	252.52
34	1/40,000	0.63131	1.0159	50.50	202.02
35	1/39,600	0.6250	1.0058	50.0	200.0
36	1/39,370	0.62138	1.	49.7104	198.88
37	1/38,400	0.6060	0.9752	48.484	193.93
38	1/38,016	0.6000	0.9656	47.925	191.70
39	1/33,792	0.5353	0.86146	42.666	170.66
40	1/30,000	0.47348	0.7619	37.8787	151.48
41	1/25,344	0.4000	0.64373	32.000	128.000
42	1/25,000	0.39457	0.63967	31.5656	126.262
43	1/23760	0.37500	0.60349	30.	120.000
44	1/21,120	0.33333	0.53589	26.666	106.666
45	1/20,000	0.31565	0.50798	25.2525	101.0101
46	1/19,800	0.31250	0.50290	25.	100.
47	1/19,200	0.30303	0.48762	24.242	96.969

lineal inch of Map, the following number of

No.	Metres,	Yards and Feet { of Actual Distance.		Where Used.
1	186682.18	204160.00	612480.00	Map of U. S. in atlas.
2	53107.86	58080.00	174240.00	Map of Pa.
3	32186.635	35200.00	105600.00	U. S. C. S.
4	30479.7	33333.33	100000.0	U. S. C. S.
5	25749.27	28160.0	84480.0	△ India.
6	25399.2	27755.77	83333.3	U. S. C. S.
7	20599.416	22528.00	67584.00	
8	19312.95	21120.00	63360.00	R. R. Va.
9	16128.6	17638.89	52916.66	U. S. C. S.
10	16093.29	17600.00	52800.00	U. S. Eng.
11	15239.8	16666.6	50000.0	U. S. C. S.
12	12874.65	14080.0	42240.0	Eng. Ord. Sur.
13	12699.6	13888.8	41666.6	U. S. C. S.
14	10159.7	11111.1	33333.3	U. S. C. S.
15	9655.87	10560.0	31680.0	Ludlow's Rep.
16	9523.9	10416.5	31250.0	U. S. C. S.
17	8046.64	8800.00	26400.0	Barnes' Pa. Maps, 1851.
18	7619.9	8344.3	25000.0	U. S. C. S.
19	6095.7	6666.6	20000.0	U. S. C. S.
20	5079.8	5555.5	16666.6	U. S. C. S.
21	4827.935	5280.0	15840.0	Ludlow's Rep.
22	4063.8	4444.4	13333.3	U. S. C. S.
23	3804.9	4166.6	12500.0	U. S. C. S.
24	3218.66	3520.0	10560.0	Sherman's March.
25	3057.8	3333.3	10000.0	U. S. C. S.
26	2539.9	2777.7	8333.3	U. S. C. S.
27	2031.9	2222.2	6666.6	U. S. C. S.
28	2011.7	2200.0	6600.0	
29	1960.5	2133.33	6400.0	Geol. Sur.
30	1609.3	1760.0	5280.0	Fremont.
31	1523.9	1666.6	5000.0	U. S. C. S.
32	1508.73	1650.0	4950.0	
33	1269.9	1388.8	4166.6	U. S. C. S.
34	1015.9	1111.1	3333.3	U. S. C. S.
35	1005.83	1100.0	3300.0	U. S. C. S.
36	1000.0	1093.6	3280.8	
37	975.24	1066.66	3200.0	Geol. Surv.
38	965.59	1054.33	3163.0	
39	861.458	938.66	2816.0	
40	761.9	833.3	2500.0	U. S. C. S.
41	643.728	704.000	2112.000	
42	639.673	694.44	2083.333	
43	603.487	660.00	1980.000	
44	535.8969	586.66	1760.000	
45	507.98	555.5	1666.66	
46	502.906	550.00	1650.00	U. S. C. S.
47	487.617	533.333	1600.00	

Table of Map Equivalents giving for each

No.	Scale.	Miles,	Kilometers,	Chains,	Poles.
48	$\frac{1}{18,818}$	0.29700	0.47796	23.760	95.04
49	$\frac{1}{15,840}$	0.25000	0.40232	20.	80.
50	$\frac{1}{15,000}$	0.23674	0.38099	18.9393	75.75
51	$\frac{1}{11,880}$	0.18750	0.30174	15.	60.
52	$\frac{1}{10,000}$	0.1578	0.25417	12.626	50.505
53	$\frac{1}{9,900}$	0.15625	0.25100	12.500	50.000
54	$\frac{1}{9,600}$	0.15151	0.24376	12.121	48.484
55	$\frac{1}{7,920}$	0.12500	0.20112	10.	40.000
56	$\frac{1}{7,200}$	0.1136	0.18378	9.0909	36.363
57	$\frac{1}{6,000}$	0.09471	0.15285	7.5757	30.303
58	$\frac{1}{5,940}$	0.09275	0.15092	7.5000	30.000
59	$\frac{1}{5,000}$	0.078913	0.12695	6.31313	25.252
60	$\frac{1}{4,950}$	0.078123	0.12582	6.250	25.000
61	$\frac{1}{4,800}$	0.07575	0.121881	6.0606	24.242
62	$\frac{1}{3,960}$	0.06250	0.100561	5.	20.000
63	$\frac{1}{3,600}$	0.05681	0.091391	4.5303	18.1212
64	$\frac{1}{3,333}$	0.05261	0.08463	4.2060	16.8242
65	$\frac{1}{3,168}$	0.05	0.080466	4.	16.000
66	$\frac{1}{3,000}$	0.04734	0.07610	3.7787	15.151
67	$\frac{1}{2,970}$	0.04687	0.07541	3.75	15 000
68	$\frac{1}{2,500}$	0.03945	0.06396	3.1565	12.626
69	$\frac{1}{2,400}$	0.03787	0.06098	3.0379	12.1515
70	$\frac{1}{1,980}$	0.03125	0.05029	2.5	10.000
71	$\frac{1}{1,280}$	0.02020	0.032507	1.6016	6.406
72	$\frac{1}{1,250}$	0.019728	0.031697	1.5767	6.307
73	$\frac{1}{1,200}$	0.018939	0.030578	1.5151	6.060
74	$\frac{1}{1,080}$	0.017046	0.027520	1.3636	5.454
75	$\frac{1}{960}$	0.01515	0.024376	1.2121	4.848
76	$\frac{1}{840}$	0.013258	0.021399	1.06057	4.2420
77	$\frac{1}{792}$	0.0125	0.02011	1.	4.
78	$\frac{1}{720}$	0.01136	0.018378	0.9091	3.6363
79	$\frac{1}{600}$	0.009471	0.015285	0.75757	3.0303
80	$\frac{1}{500}$	0.0078913	0.012695	0.63131	2.5252
81	$\frac{1}{480}$	0.007575	0.012188	0.60606	2.4242
82	$\frac{1}{360}$	0.00568	0.009139	0.45303	1.81212
83	$\frac{1}{300}$	0.004734	0.007610	0.37787	1.51515
84	$\frac{1}{240}$	0.003787	0.006098	0.30379	1.21515
85	$\frac{1}{198}$	0.003125	0.005029	0.25	1.
86	$\frac{1}{120}$	0.001894	0.003057	0.15151	0.6060
87	$\frac{1}{89}$	0.000947	0.001528	0.07575	0.3030
88	$\frac{1}{39,370.43}$	0.0006213	0.001	0.0497101	0.1988405
89	$\frac{1}{36}$	0.000568	0.0009139	0.045303	0.181212
90	$\frac{1}{12}$	0.0001894	0.0003057	0.015151	0.0606
91	$\frac{1}{1}$	0.00001578	0.00002536	0.0012595	0.00505
92	$\frac{4}{8}$	0.000011835	0.0000190	0.0009467	0.003787
93	$\frac{2}{1}$	0.00000789	0.00001268	0.0006297	0.002525

lineal inch of Map, the following number of

No.	Metres,	Yards and Feet { of Actual Distance.		Where Used.
48	477.96	522.72	1568.1	U. S. C. S.
49	402.325	440.00	1320.00	
50	380.99	416.66	1250.00	U. S. C. S.
51	301.744	330.00	990.00	
52	254.177	277.77	833.33	U. S. C. S.
53	251.004	275.000	825.00	
54	243.763	266.66	800.	
55	201.125	220.00	660.	
56	183.782	200.	600.	
57	152.854	166.66	500.	
58	150.924	165.00	495.	
59	126.950	138.888	416.66	U. S. C. S.
60	125.8238	134.166	412.50	
61	121.88175	133.333	400.	
62	100.5625	110.0	330.	
63	91.391	100.	300.00	
64	84.6334	92.592	277.777	U. S. C. S.
65	80.0466	88.	264.	
66	76.1057	83.333	250.00	
67	75.4138	82.5	247.5	
68	63.9673	69.444	208.33	U. S. C. S.
69	60.9811	66.666	200.	U. S. C. S.
70	50.2906	55.55	166.66	
71	32.5079	35.555	106.66	U. S. C. S.
72	31.6973	34.7222	104.166	U. S. C. S.
73	30.578	33.3333	100.	U. S. C. S.
74	27.520	30.	90.	
75	24.3763	26.666	80.	
76	21.4046	23.3333	70.	
77	20.1125	22.	66.	
78	18.3782	20.	60.	
79	15.2854	16.666	50.	
80	12.695	13.8888	41.666	U. S. C. S.
81	12.18817	13.3333	40.	
82	9.1391	10.	30.	
83	7.61057	8.3333	25.	
84	6.09811	6.6666	20.	
85	5.02906	5.555	16.666	
86	3.0578	3.3333	10.	U. S. C. S.
87	1.52854	1.6666	5.	
88	1.	1.093623	3.280869	
89	0.91391	1.	3.	
90	0.30578	0.3333	1.	
91	0.025368	0.02777	0.083	
92	0.019026	0.020833	0.0625	
93	0.012684	0.013888	0.0415	

A Reciprocal Table of Map Equivalents showing the number of inches of

No.	Scale.	1 Mile.	1 Kilometer.	1 Chain.	1 Pole.
1	1/7,349,760	0.0086205	0.005359	0.00010775	0.00002693
2	1/2,090,880	.03030	.01882	.000378	.0000945
3	1/1,267,200	.05000	.03106	.000625	.00015625
4	1/1,200,000	.05280	.03280	.000660	.0001650
5	1/1,013,760	.06250	.03883	.000781	.00019525
6	1/1,000,000	.06336	.03937	.000792	.00019800
7	1/811,008	.078125	.04854	.0009765	.0002441
8	1/760,320	.08333+	.05177	.001041	.00026025
9	1/635,000	.09979	.06199	.001247	.00031175
10	1/633,600	.10000	.06213	.001250	.0003125
11	1/600,000	.10560	.06561	.00132	.0003300
12	1/506,880	.12500	.07766	.001562	.0003905
13	1/500,000	.12672	.07874	.001584	.0003960
14	1/400,000	.15840	.09842	.00198	.0004950
15	1/380,160	.16666+	.10355	.002083	.00052075
16	1/375,000	.16896	.10498	.002112	.00052800
17	1/316,800	.20000	.12426	.00250	.0006250
18	1/300,000	.21120	.13122	.00264	.0006600
19	1/240,000	.26400	.16403	.003300	.008250
20	1/200,000	.31680	.19684	.003960	.0009900
21	1/190,080	.33333+	.20711	.004166	.0010415
22	1/160,000	.39600	.24605	.004950	.0012325
23	1/150,000	.42240	.26245	.005280	.0013200
24	1/126,720	.50000	.31067	.006250	.0015625
25	1/120,000	.52800	.32807	.006600	.0016500
26	1/100,000	.63360	.39368	.00792	.0019800
27	1/80,000	.79200	.49210	.009900	.0024750
28	1/79,200	.8	.497101	.01	.0025
29	1/76,800	.82500	.51261	.010312	.0025780
30	1/63,360	1.00000	.62130	.012500	.0031250
31	1/60,000	1.05600	.65614	.013200	.003300
32	1/59,400	1.066666	.662801	.013333	.00333
33	1/50,000	1.26720	.78737	.01585	.0039625
34	1/40,000	1.58400	.98421	.019800	.004950
35	1/39,600	1.6	.994202	.02	.00500
36	1/39,369	1.60934	1.00000	.020116	.0050290
37	1/38,400	1.65000	1.02522	.020622	.00515550
38	1/38,016	1.66666	1.03509	.0208333	.0052083
39	1/33,792	1.875000	1.16537	.023437	.005859
40	1/30,000	2.11200	1.31228	.026400	.0066000
41	1/25,344	2.50000	1.55334	.031250	.0078125
42	1/25,000	2.53440	1.57474	.031680	.0079200
43	1/23,760	2.66666+	1.65692	.03333+	.008333+
44	1/21,120	3.00000	1.86403	.037500	.0093750
45	1/20,000	3.16800	1.96842	.03960	.009900
46	1/19,800	3.2	1.988404	.04	.010
47	1/19,200	3.30000	2.05044	.04125	.0103125

Map and parts thereof, of the various scales now in use, which represent

No.	1 Metre.	1 Yard.	1 Foot.	Where Used.
1	.000005359	00000489	.00000163	[(Military.)
2	.00001882	.0000172	.00000573+	Sherman's March Map.
3	.00003106	.0000284	.00000946+	" "
4	.00003280	.0000300	.00001000	U. S. C. S.
5	.00003883	.0000355	.00001183+	△ India.
6	.00003937	.00003600	.00001200	U. S. C. S.
7	.00004854	.00004438	.00001446	
8	.00005177	.0000473	.00001576+	R. R. Virginia.
9	.00006199	.0000566	.00001553+	U. S. C. S.
10	.00006213	.0000568	.000015600	U. S. Eng's.
11	.00006561	.0000600	.0000200	U. S. C. S.
12	.00007766	.0000710	.0000236+	Eng. Ord. Sur.
13	.00007874	.0000720	.0000240	U. S. C. S.
14	.00009842	.0000900	.0000300	U. S. C. S.
15	.00010355	.0000946	.00003153+	Ludlow's Rep.
16	.00010498	.0000960	.00003200	U. S. C. S.
17	.00012426	.0001136	.00003753+	Barnes' Pa. Map, 1851.
18	.00013122	.0001200	.0004000	U. S. C. S.
19	.00016403	.0001500	.0000500	U. S. C. S.
20	.00019684	.000180	.0000600	U. S. C. S.
21	.00020711	.0001893	.0006310	Ludlow.
22	.00024605	.0002250	.00007300	U. S. C. S.
23	.00026245	.0002400	.0000800	U. S. C. S.
24	.00031067	.0002840	.0000946+	Sherman's March
25	.00032807	.0003000	.0001000	U. S. C. S.
26	.00039368	.0003600	.0001200	U. S. C. S.
27	.00049210	.0004500	.00015000	U. S. C. S.
28	.0004971	.0004545	.00015151	
29	.00051261	.00046875	.00015625	Geol. Surv.
30	.00062130	.00056800	.00018933+	Fremont.
31	.00065614	.000600	.000200	U. S. C. S.
32	.000662	.00060606	.00020202	
33	.00078737	.000720	.0002400	" "
34	.00098421	.000900	.000300	" "
35	.0009941	.0009090	.0003030	
36	.0010000	.0009144	.0003048	
37	.00102522	.0009375	.0003125	Geol.
38	.001035	.000947	.0003156	
39	.0011653	.0010653	.0003551	
40	.00131228	.0012000	.0004000	U. S. C. S.
41	.00155334	.0014190	.0004730	
42	.00157474	.00144000	.0004800	
43	.00165692	.00151515	.00050505	
44	.00186403	.0017040	.0005680	
45	.00196842	.0018000	.0006060	
46	.001988	.001818	.0006060	
47	.00205044	.00187500	.0062500	

A Reciprocal Table of Map Equivalents showing the number of inches of

No.	Scale.	1 Mile.	1 Kilometer.	1 Chain.	1 Pole.
48	$\frac{1}{18,818}$	3.36698	2.09206	.042087	.0105275
49	$\frac{1}{15,840}$	4.0	2.485507	.05	.0125
50	$\frac{1}{15,000}$	4.22400	2.62456	.052800	.0132000
51	$\frac{1}{11,880}$	5.33333	3.314009	.06666	.016666
52	$\frac{1}{10,000}$	6.33600	3.93685	.079200	.0198000
53	$\frac{1}{9,900}$	6.4	3.976808	.08	.020
54	$\frac{1}{9,600}$	6.60000	4.10088	.082500	.020625
55	$\frac{1}{7,920}$	8.	4.971014	.10	.025
56	$\frac{1}{7,200}$	8.80000	5.46784	.11000	.027500
57	$\frac{1}{6,000}$	10.56000	6.561423	.132000	.033000
58	$\frac{1}{5,940}$	10.6666	6.628018	.133333	.03333
59	$\frac{1}{5,000}$	12.67200	7.8737	.15840	.039600
60	$\frac{1}{4,950}$	12.8	7.953616	.16	.04
61	$\frac{1}{4,800}$	13.20000	8.201770	.165000	.041250
62	$\frac{1}{3,960}$	16.	9.942028	.2	.05
63	$\frac{1}{3,600}$	17.6	10.93568	.22	.055
64	$\frac{1}{3,333}$	19.00990	11.81173	.237623	.05940575
65	$\frac{1}{3,168}$	20.	12.42434	.25	.0625
66	$\frac{1}{3,000}$	21.12	13.122846	.264	.066
67	$\frac{1}{2,970}$	21.33333	13.256036	.26666	.06666
68	$\frac{1}{2,500}$	25.34400	15.74740	.31680	.079200
69	$\frac{1}{2,400}$	26.40000	16.40354	.330000	.082500
70	$\frac{1}{1,980}$	32.	19.88405	.4	.1
71	$\frac{1}{1,280}$	49.50000	22.94414	.618750	.1546875
72	$\frac{1}{1,250}$	50.68800	31.49480	.63360	.158400
73	$\frac{1}{1,200}$	52.80000	32.80708	.660000	.165000
74	$\frac{1}{1,080}$	58.66666+	36.45231	.73333+	.18333+
75	$\frac{1}{900}$	66.00000	41.00885	.825000	.206250
76	$\frac{1}{840}$	75.42857	46.86726	.942857	.23571425
77	$\frac{1}{789}$	80.30418	49.89670	1.003802	.2509505
78	$\frac{1}{720}$	88.00000	54.67847	1.100000	.275000
79	$\frac{1}{600}$	105.60000	65.61416	1.320000	.33000
80	$\frac{1}{500}$	126.72000	78.73700	1.584000	.39600
81	$\frac{1}{480}$	132.00000	82.01770	1.650000	.412500
82	$\frac{1}{360}$	176.00000	109.35694	2.2000	.550000
83	$\frac{1}{300}$	211.20000	131.22833	2.640000	.66000
84	$\frac{1}{240}$	264.00000	164.03541	3.300000	.825000
85	$\frac{1}{198}$	320.	198.8405	4.	1.
86	$\frac{1}{120}$	528.00000	328.07083	6.600000	1.65000
87	$\frac{1}{60}$	1056.00000	656.14166+	13.20000	3.3000
88	$\frac{1}{39.3704}$	1609.330	1000.	20.11663	5.02916
89	$\frac{1}{36}$	1760.	1083.5694	22.	5.5
90	$\frac{1}{12}$	5280.00000	3280.7083	66.00000	16.5000
91	$\frac{1}{1}$	63360.00000	39368.5000	792.0000	198.000
92	$\frac{4}{3}$	84480.00	52491.0333+	1056.000	264.000
93	$\frac{2}{1}$	126720.00	78737.0000	1584.000	396.000

Map and parts thereof, of the various scales now in use, which represent

No.	1 Metre.	1 Yard.	1 Foot	Where Used.
48	.00209206	.0019130	.0006376+	U. S. C. S.
49	.002485	.002272	.0007575	
50	.00262456	.0024000	.0008000	U. S. C. S.
51	.003314	.0030303	.0010101	
52	.00393685	.0036000	.0012000	U. S. C. S.
53	.003976	.003636	.001212	
54	.00410088	.00375	.0012500	
55	.004970	.004544	.0015150	
56	.00546784	.005000	.001666+	
57	.006561423	.006000	.002000	
58	.006628	.0060606	.0020202	
59	.0078737	.007200	.002400	U. S. C. S.
60	.007952	.007272	.002424	
61	.008201770	.0075000	.002500	
62	.00994	.009088	.003030	
63	.0109356	.01	.003999	
64	.01181173	.0108010	.003603+	U. S. C. S.
65	.012424	.0113181	.0037727	
66	.0131228	.012	.004	
67	.013256	.0121212	.0040404	
68	.01574740	.014400	.0048000	U. S. C. S.
69	.01640354	.015000	.005000	U. S. C. S.
70	.0218712	.02	.007999	
71	.02294414	.0281250	.0093750	U. S. C. S.
72	.03149480	.028800	.0096000	" "
73	.03280708	.030000	.010000	" "
74	.03645231	.03333+	.0111111+	
75	.04100885	.037500	.012500	
76	.04686726	.0428547	.0142849	
77	.04989670	.0456273	.0152091	
78	.05467847	.050000	.016666+	
79	.06561416	.060000	.020000	
80	.07873700	.072000	.024000	U. S. C S.
81	.08201770	.075000	.025000	
82	.10935694	.100000	.033333+	
83	.13122833	.12000	.040000	
84	.16403541	.150000	.050000	
85	.218712	.2	.079999	
86	.32807083	.30000	.100000	U. S. C. S.
87	.6561416+	.600000	.200000	
88	1.	.914392	.304464	
89	1.093569	1.	.333333	
90	3.2807083	3.00000	1.0000	
91	39.36850	36.0000	12.0000	
92	52.49103+	48.00000	16.0000	
93	78.737000	72.0000	24.0000	